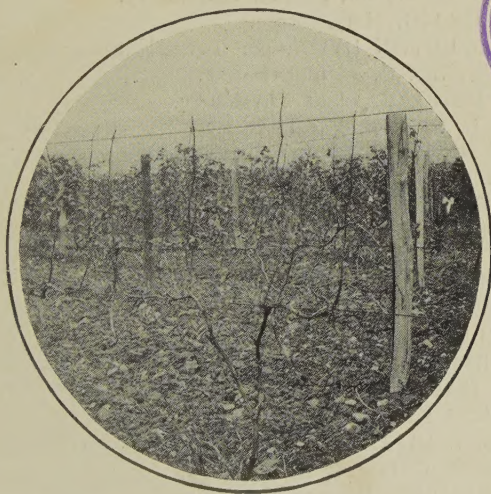

CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Plant Pathology

NECROSIS
OF THE
GRAPE VINE



By DONALD REDDICK

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NECROSIS OF THE GRAPE VINE

In drawing the ordinary implements of grape-culture through the vineyard, occasional vines are caught and broken off or their roots are torn loose, so that nearly every year new vines must be set out to replace them. Viticulturists, in a few localities, have noticed that not all of the vines that have to be replaced are broken loose but that they have "just died," while in those sections where the grape-root worm is present all such losses are laid to this insect pest.

INTRODUCTION

From a careful examination of vineyards in three of the large grape-growing regions of the State (Chautauqua, Keuka Lake and Niagara Triangle), the writer feels safe in saying that a large percentage (perhaps 50%) of vines whose death is attributed to root worm, or "just died," is due to some other cause. The fact that vines die in a similar manner in regions in which there is no root worm goes far to show that the root worm may not after all be responsible for everything attributed to it. Examination of such dead vines fails to reveal any root trouble or any insect or borer in the stem, but if microscopic examination of a thin section of the stem be made it will be found that a fungus is growing there, plugging up the sap tubes, slowly destroying the living tissue and eventually killing the vine.

Since there appears to be an organism responsible for the dying of these vines, it becomes the duty of the plant pathologist to learn the life history of the organism, the conditions of its life and growth, its means of entrance into the stem of the vine as well as to devise or discover preventive measures. From conversation with vineyardists (many of whom have been met at the various fairs), the writer has found that nearly all are acquainted with the general characters of the disease but that relatively few practical growers recognize this as a disease, much less give any thought to a means of prevention or control.

It requires much time to work out in detail all of the points in the life history of a fungous parasite, but the importance of this disease to the vineyardist seems to warrant the publication of a preliminary report in order, first, to call attention to the disease; second, to obtain

further information regarding the manifestations of the disease; and third, to suggest such preventive measures as seem most likely to be of value.¹

VARIETIES AFFECTED

In the Chautauqua belt, it is naturally the Concord that is most often affected. The disease has been seen in Niagaras, Moore's Early, Agawams, Pocklingtons, Wordens, Lindleys, Isabellas, Catawbas, and White Scuppernong, the latter from Georgia.

DISTRIBUTION

There seems little doubt but that this disease is the one described by Selby and Van Hook ('07) as localized stem blight. At the time circular 64 was written, in February 1907, the disease was known for only two localities in Ohio, namely at Unionville, Ashtabula County, and at the Experiment Station vineyard at Wooster.

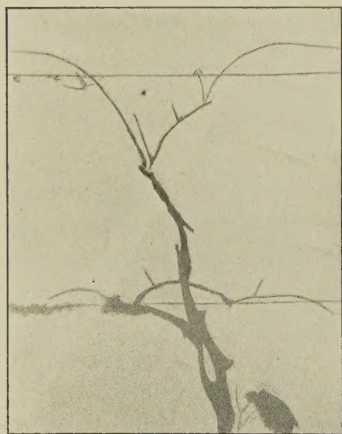


Photo July 20, 1908

FIG. 41.—Vine trimmed and tied but failed to put out shoots

Mr. E. L. Worsham sent the writer material from Atlanta, Georgia, under date of May 6, 1907, and from this the fungus causing the disease was readily isolated. This was on white Scuppernong. Prof. H. H. Whetzel, of this department, collected specimens of the disease in Noble County, Indiana, May, 1904. Erie County, Pa., Port Hope, Ontario, Canada, and California may be admitted as doubtful sections.

In New York, the disease is widely distributed in the Chautauqua belt. There, it is particularly destructive to young vines, but is also present in old vineyards where it seems to do less damage. The writer has collected or received specimens from Westfield, Brocton, Fredonia, Dunkirk, Silver Creek, Sheridan, Irving, and other places. In the "Niagara Triangle" it has been received or collected from near Hemlock, Romulus, Kendaia, Interlaken, Port Byron, Syracuse, Baldwinsville, Canandaigua Lake, and others. From the Keuka Lake

¹The writer is especially desirous of obtaining information from as many sources as possible, and solicits specimens as well as observations regarding the disease.

('07) Selby, A. D. & Van Hook, J. M. Dying of bearing grapevines. Localized stem blight in Ohio vineyards, Ohio Agr. Exp. Sta. Circ. 64:1-6, Feb. 15, 1907.

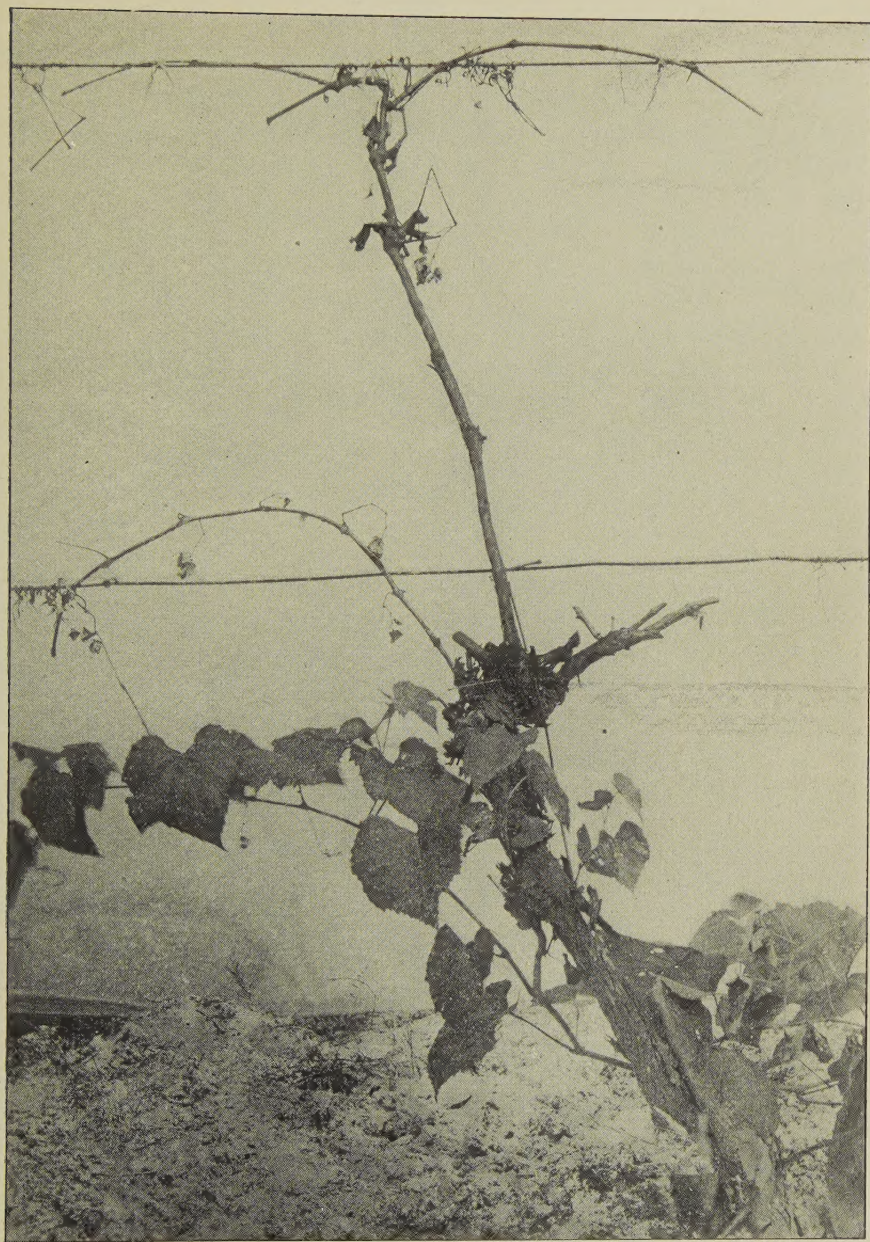


Photo. Aug. 15, 1908

FIG. 42.—*Pocklington*. *The few shoots put out in the spring soon withered and died; the root was still healthy*

region there are specimens from Branchport, Penn Yan, Catawba, Bluff Point, North Crosby, Keuka Park, and others. No specimens have ever been received from the Hudson River district, but Professor F. C. Stewart ('99) states that he has seen it there, and reports it in Bulletin 167 of the Geneva Station.

LOSSES FROM THE DISEASE

It is not possible to give an estimate of the loss caused by this disease in New York vineyards. This is due to many reasons: Losses due to this source are usually attributed to other causes; unfamiliarity with the disease as such makes all estimates too low; in the old vineyards, where the progress is slow, many vines are so slowly devitalized as to escape notice entirely; in well-kept vineyards, dead vines are replaced immediately, thus leaving no opportunity for observation as to losses.

In a few instances the writer has had opportunity to observe the ravages of the disease. In a young vineyard of 14 acres, three years up, careful observations were made in August, 1907, and at a fair estimate 4,000 to 5,000 vines were dead or dying. In another vineyard of 20 acres, the owner thinks at least one-third of the vines are dead, and from personal observation the writer thinks this a fair estimate. In 10 acres of Moore's Early at Romulus, N. Y., where little attention has been given to renewing, at least 10 per cent. of the vines are dead or show symptoms of the disease. Nearly half the vines in a Niagara vineyard of 28 acres at Hemlock have the fungus in them and a few of them have failed to set fruit this year, while others are dead or in a dying condition. In some vineyards or in certain parts of others only an occasional vine shows any signs of the disease.

SIGNS OR SYMPTOMS OF THE DISEASE

There are many signs by which the disease may be recognized in the field:

- (a). A trimmed and tied vine that has failed to put out shoots (Fig. 41). Such a vine usually splits open longitudinally during hot weather.
- (b). A vine that has sent forth shoots, the latter dying after a few weeks (Fig. 42).
- (c). Vines on which all or part of the shoots and leaves exhibit a dwarfing; internodes short and leaves very small and often crimped about the margin (Fig. 57). This symptom is observable from a distance.

('99) Stewart, F. C. & Blodgett, F. H. A Fruit Disease Survey of the Hudson Valley in 1899. N. Y. Agr. Exp. Sta. Bull. 167:297-299, 1899.

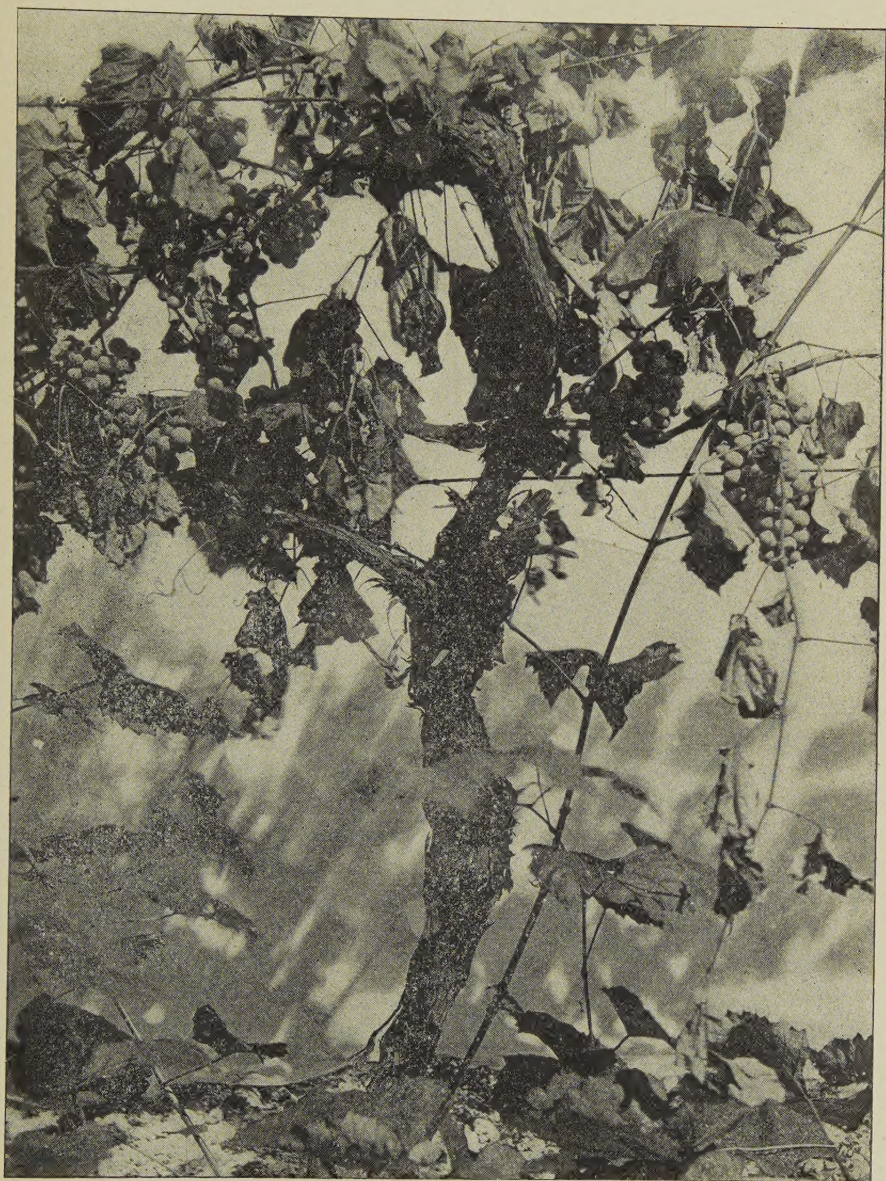


Photo. Aug. 15, 1908

FIG. 43.—*Worden*. See also Fig. 54, which is the same vine

(d). Leaves of nearly normal size showing a blanched or chlorotic condition and often crimped about the margin.



Photo. Sept. 7, 1907

FIG. 44.—*Concord*. Excrescences on a main stem of a seven-year-old vine

(e). Apparently healthy vines with leaves and fruit shriveling away and dying in the middle of or late in the summer.

(f). The presence of fleshy or corky excrescences on the stem and arms during the summer; in the autumn these dry down and become reddish brown and the following spring slough off. They have somewhat the appearance of new growth to heal a wound and are in longitudinal ribs, 1-6 inches long; globose, tumorous bodies $\frac{1}{2}$ -3 inches in diameter, on one side of the stem, or a gnarled growth encircling the stem near the base (Figs. 44, 45, 46, 47).

(g). The presence of minute black pimples, fruiting bodies of a fungus, on a dead spur, on dead bark or on dead wood under the bark. (Fig. 50.)

(h). The presence of small reddish brown spots on the green shoots (Fig. 48). The spots may be one-eighth of an inch in diameter and distinct; anastomosed to form a continuous diseased area sometimes extending for an inch or more up and down and half-way round the shoot; or in narrow, v-shaped, longitudinal slits.

(i). Any of the above conditions may refer to one arm only, and any vine may show only a few to nearly all of the conditions named. (Fig. 49.)

NAME OF THE DISEASE

This disease has been called Anthracnose by Atkinson ('04). Selby and Van Hook ('07) refer to it as localized stem blight. From an examination of the brief descriptions it seems not

- ('04) Atkinson, G. F. Anthracnose of the Grape. Agr. Exp. Sta. of the Coll. of Ag., Cornell Univ. Press Bulls. 1 and 2, April 25, 1904.
 ('07) Selby, A. D. & Van Hook, J. M. (1. c.)

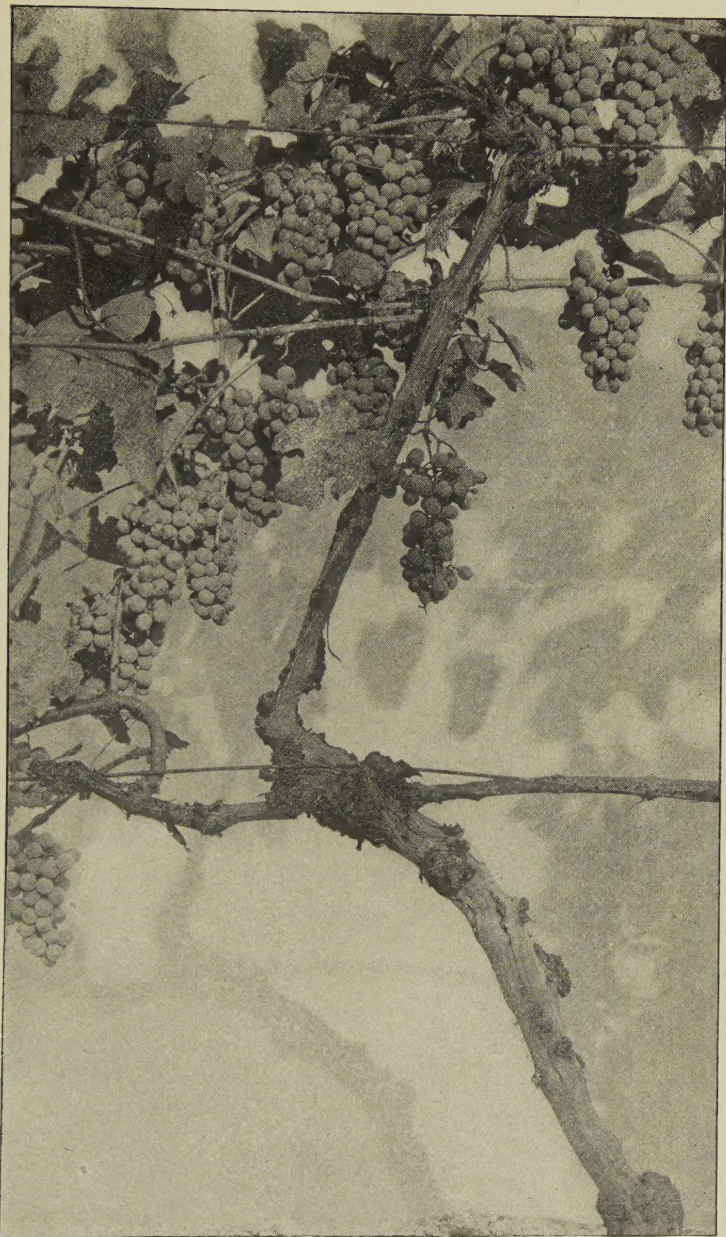


Photo Aug. 20, 1908

FIG. 45.—Niagara. Globose swellings on a vine well loaded with fruit
The *Fusicoccum* fungus has been isolated from this vine

improbable that this disease was referred to by Galloway ('89) as Black Knot of the grape, and said to be due to frost injury; by Fletcher ('89) also as Black Knot; by Woodworth ('92) as Root Knot or commonly as Black Knot. The material which Fletcher examined was sent to Dr. W. G. Farlow of Harvard University, who suggested that "the



Photo. Aug. 20, 1908

FIG. 46.—Niagara. Enlarged view of an excrescence seen in Fig. 45 (natural size)

trouble, however, is climatic rather than fungous," and perhaps due to frost injury. The frost-injury idea is a very common one. Growers commonly refer to the disease as Side Arm, Dead Arm or Black Knot.

In European literature, we find numerous references to diseases of the vine. Besides root and stem diseases ascribed to *Dematophora*, *Armillaria*, and the like, there are a number of so-called physiological diseases. These are described under various captions such as Folletage, Chlorosis, Rougeot, Broussins, Exotoses, Fongosités, or Tubercoli. Viala ('93) has described and illustrated a disease, Broussins (excrescences), as due to frost injury. From descriptions of general appearances one might easily believe that nearly any of the above were the same disease as the one with which we are dealing. Some of

the illustrations, especially those of Viala, might be readily used to illustrate this paper, since the points of similarity are so great.

- ('89) Galloway, B. T. A record of some of the work of the Division. Part II, Section of Vegetable Pathology. U. S. D. A., Bot. Div. Bull. 8:63, 1889.
- ('89) Fletcher, Jas. Report of the Entomologist and Botanist. Rept. Can. Exp. Farm, 1889, p. 87.
- ('92) Woodworth, C. W. Root Knots on Fruit Trees and Vines. Univ. Cal. Agr. Exp. Sta. Bull. 99:1-4, 1892.
- ('93) Viala, P. Les Maladies de la Vigne, Troisième édition 1893. I. c. p. 489-490, Figs. 227-232.

The relation of this disease to these "physiological diseases," however, as yet remains a matter of investigation, so that none of these names could be applied with any degree of certainty. Anthracnose is untenable since that disease has distinctive and entirely different characters. Side Arm is not a good name to apply since it more frequently happens that the whole vine is attacked. Black Knot by common consent is reserved for the Knot in plums and cherries and is entirely different.

None of these names seems tenable since they are either grossly incorrect or when descriptive do not express the whole truth and are unaccompanied by name of fungus so that identity is uncertain. It therefore seems that *Necrosis* (L., Gr. nekrosis, a killing, nekros, corpse) would be a more suitable name.

ETIOLOGY

Nature of the causal parasite.

This disease is caused by a fungus (*Fusicoccum viticolum* n. sp.).¹ It is a vege-

¹ Descriptions of various fungi known to occur on species of *Vitis* have been carefully examined but no species seem to have been described to which this might correspond. While it is quite possible that a so-called perfect stage may eventually be found, none is known at the present time. For that reason, the fungus must be placed in some one of the imperfect "form genera." *Fusicoccum* has been chosen in preference to *Dothiorella* because of the presence of numerous paraphyses. Some of the described species of *Fusicoccum* have paraphyses while none of the *Dothiorellae* are described as having paraphyses.

Fusicoccum viticolum, Reddick, n. sp. Stromatibus rotundis ovoideisve; sparsis vel confluentibus vel dense gregariis; tectis, dein erumpentibus; nigris; carbonaceis; spurie plurilocellatis (1-6); ostiolo non prominente perforato-punctatis; sporulis



Photo Sept. 8, 1908

FIG. 47.—*Isabella*. Excrescences on two-year-old renewals, Keuka Lake

table parasite and is so small that it cannot be seen except with the aid of a compound microscope.

When one examines the diseased part of a stem microscopically, he can find in and between the cells of the wood extremely minute cobweb-



Photo. June 27, 1908

FIG. 48.—*Niagara*. Lesions of the disease on green shoots

like threads called *mycelium*. This mycelium constitutes the vegetative part of the fungus. It feeds on the substance of the wood cells, and other parts, gradually destroying them and producing a dry rot.

The fungus may vegetate for several years and its presence in the stem sets up an irritation in the living tissue. The vine is excited to excessive growth in certain regions as though it were trying to throw off the irritant. This excessive growth is manifest to the eye as large, tumorous swellings (Figs. 45, 46, 47), or fleshy, longitudinally-ribbed excrescences (Fig. 44). As the sap tubes are slowly attacked and killed, the amount of water that reaches the leaves and growing parts becomes less and less. This causes a dwarfing of the shoots and blanching of the leaves. Often, all the leaves cannot be supported and some turn yellow and die. For the same reason, fruit buds are developed sparingly and the fol-

lowing year the vine either fails entirely to set fruit, or the setting is light.

When the fungus has encroached far enough upon the living tissue completely to cut off the sap supply, the vine dies. This may happen

subfusoides, continuis, hyalinis, rectis vel leniter curvis, 6.3—11.2 x 1.7—2.8; basidiis longibus, crassis paraphysibusque filiformibus, longioribus intermixtis.

Hab. in ramis truncisque exsiccatis *Vitis labruscae* et *rotundifolia* vars.

at any time of the year. Often it is in the winter. A vine may apparently be healthy, trimmed and tied up and then fail to put forth shoots: in other cases, the vine may send out, in the spring, shoots which after a few weeks wither and die; or the collapse may not come until the middle of or late in the summer.



Photo. Aug. 26, 1908

FIG. 49.—*Moore's Early* (?). Internodes short, no fruit, margins of leaves crimped, some of the leaves blached, two arms entirely dead

The fungus, like any other plant, develops bodies for reproduction and dissemination. These bodies are called spores, or pycnospores. and although they are much simpler in structure (being composed of a single cell) than a seed they perform the same function for the fungous plant. As long as the grape vine lives there is food for the

fungus and future vegetative development is assured. It is only when the vine dies that there is need for reproductive bodies.

Examination of dead vines, or the dead part of large stems, late in the autumn or early winter will show a great quantity of very small pimples, *pycnidia* (Fig. 50). These are formed by external growth of the mycelium and are composed of modified mycelial threads.



Photo. Oct. 26, 1908

FIG. 50.—Concord. *Pycnidia of the fungus on canes. Loose bark stripped off*

Early in the spring, the interior of these bodies (*pycnidia* becomes filled with hyaline, slightly curved *pycnospores* which are small and can be seen only with the microscope (Fig. 51). They are variable in size and shape and can be seen in Figure 52. They measure from 6.3 to 11.2×1.7 to 2.8 micromillimeters ($1 \text{ mmm} = 1/25000 \text{ inch}$). In May and June, these spores are mature, and with the absorption of moisture after a rain or heavy dew the gelatinous substance that surrounds them swells and forces the spores out of the top of the *pycnidium* in a stream. It is easy to find such streams of spores which are one-quarter inch in length or even longer.

Germination of spores

The spores when placed in a drop of water will germinate in 18 hours or less, and the germ tube (Fig. 52) elongates to form a new thread of mycelium. If such spores are taken under sterile conditions¹

¹The best success in obtaining pure cultures came by direct transfer method. More than 75 per cent. of transfers made in that way were pure cultures. The poured-plate method was also used and pure cultures obtained in that way. The method was not satisfactory, however, since the spores did not germinate in the agar which I had with me in the field and, as they became very hyaline, were difficult to locate.

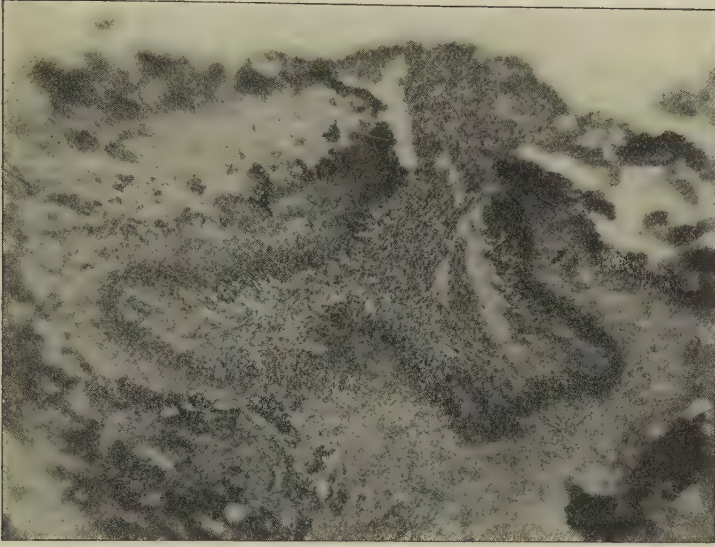


Photo. Nov. 2, 1908

FIG. 51.—Photomicrograph of a pycnidium. The spores stream out through the opening at the apex



Original

FIG. 52.—Drawing to show relation of parasite to host, compound pycnidium, germinated spores, and paraphyses

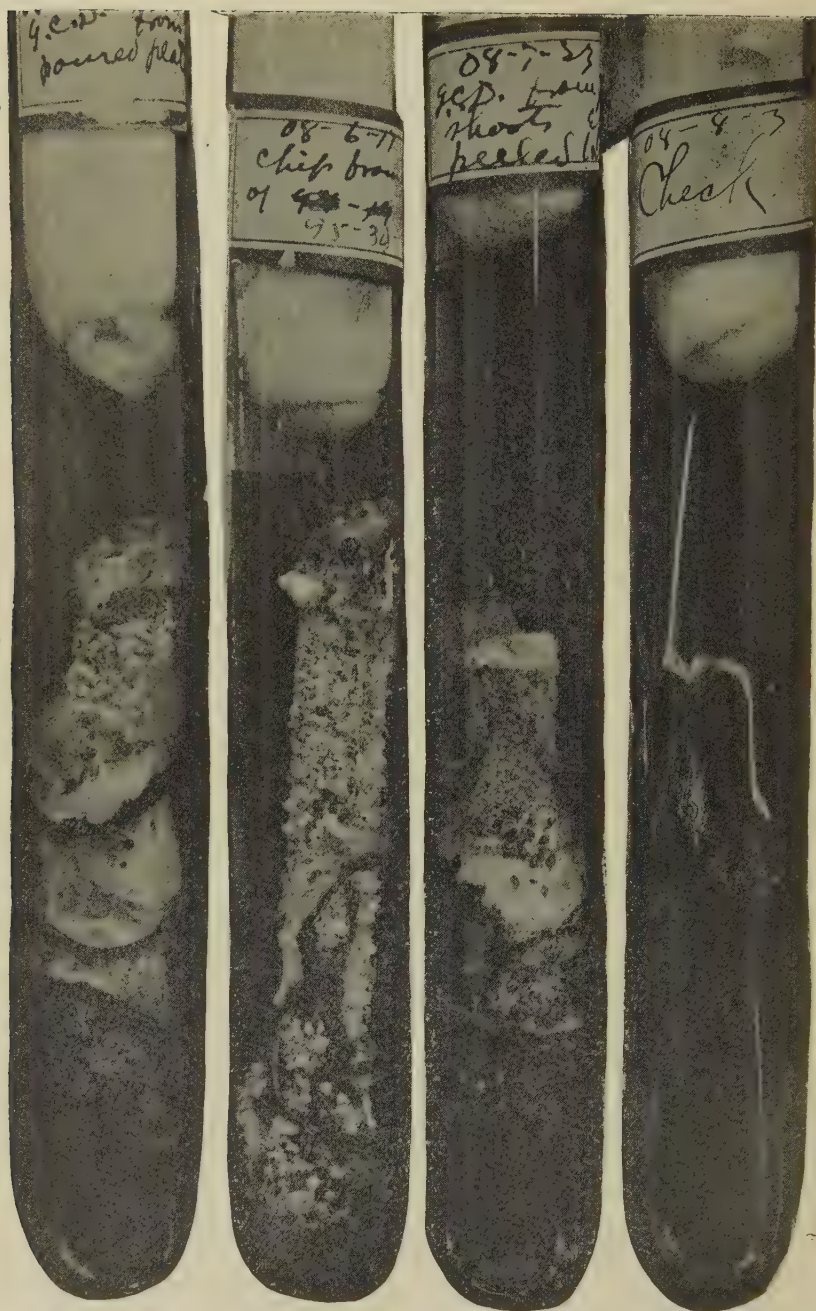


Photo. Oct. 26, 1908

FIG. 53.—Pure cultures of *Fusicoccum viticolum*. From left to right, the first is from a poured plate, the second a chip of diseased wood transferred from interior of a stem, the third from green shoots, the epidermis peeled back, the fourth a check, a stem sterilized Aug. 3, 1908

and removed to a sterilized medium in a test tube (Fig. 53), they soon grow and develop a felted grayish white growth. After a period of time, ranging from two to six weeks, new pycnidia will be formed which have the same structure and bear spores identical with the ones from the original stem. This process constitutes what is known as making a culture.

Now the presence of mycelium in the diseased grape stem may be demonstrated without the aid of a microscope and at the same time the identity of this mycelium with the fruiting bodies on the surface established. The process is another culture method. If the stem of a diseased vine be split open carefully, in order to prevent contamination from the propagative bodies of molds, mildews, etc., which are lodged in the bark or are floating about in the air, and a small portion of the interior removed with sterile instruments to a tube containing sterilized grape stems or some other nutrient medium, in a few days a felted grayish white vegetable growth or mold will spread out from the chip thus transferred and grow on the sterile stem (Fig. 53). The general appearance of the growth is identical with that described as having spores for its origin. Such cultures also develop fruiting bodies after the usual period of time and these

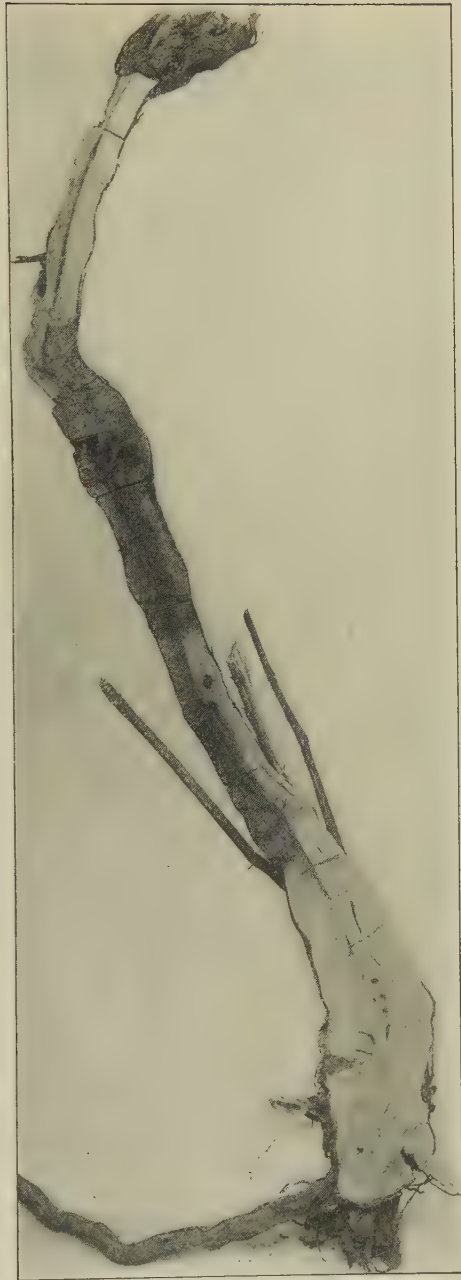


Photo. Aug. 20, 1908.]

FIG. 54.—Worden. Shows progress of the disease from a first wire crown; root crown still healthy. (Same vine as is shown in Fig 43)

as well as the spores they contain are identical in every respect with those developed normally on the dead stem.

Behavior of the spores under natural conditions

We have seen that under artificial conditions spores will grow, produce a mycelial growth and in turn reproduce more spores. Under natural conditions, there are many obstacles that prevent the spores of the fungus from accomplishing their normal function. Were it not so our vineyards would be completely destroyed in a very few years, owing to the enormous quantity of spores developed on each diseased stem, and the very wide geographical distribution of the disease.

The gelatinous substance that aided in getting the spores outside the pycnidium now becomes a hindrance. When exposed to air the substance dries and holds the spores in a firm mass, thus preventing ready dissemination by means of the wind. Water seems to be necessary to free the spores and this only comes with a rain or heavy dew. Moreover, the moisture which allows dissemination is also necessary for germination. So far as is known, one of three fates awaits the spores which are thus developed and extruded:

(1). Some are washed by rain to green parts of the vine where, if conditions remain favorable, infections are produced (Fig. 48). The lesion begins as a small discolored spot which soon becomes brown or even black, and either forms a depression or a longitudinal v-shaped slit. There may be tinges of red about the margin of the lesion, but there is never a bright red elevated margin as in the case of the anthracnose on stems.

(2). Others are washed to a wound or dead stub of the vine and there may grow and develop mycelium. No positive proof of this fact is yet at hand. Infection experiments are now under way to determine this point, if possible. The fungus progresses so slowly that it may be a number of years before results are obtained.

(3.) By far the greater part of the spores are washed free by the rain and lodge in places where growth is not possible and die.

Other means of dissemination and infection

Observations in the field lead the writer to believe that spores do not play the most important part in the dissemination of the disease in the vineyard. One can frequently find cases when the disease seems to be localized in an arm (Fig. 49), or in the two lower arms (Kniffen system), while all other parts seem to be healthy. Since the trimmer

does not recognize a diseased vine (this is evidenced by the fact that many vines are trimmed and tied up and still fail to put out shoots), he goes from diseased to healthy vines and often carries a very small sliver of diseased wood on his shears or saw, which is deposited in the healthy vine. It would be exceptional and purely accidental if he should infect every arm of a vine at a single trimming.

It is not an uncommon sight to see vines injured near the base from bruises by the various implements. In this way, also, diseased tissue

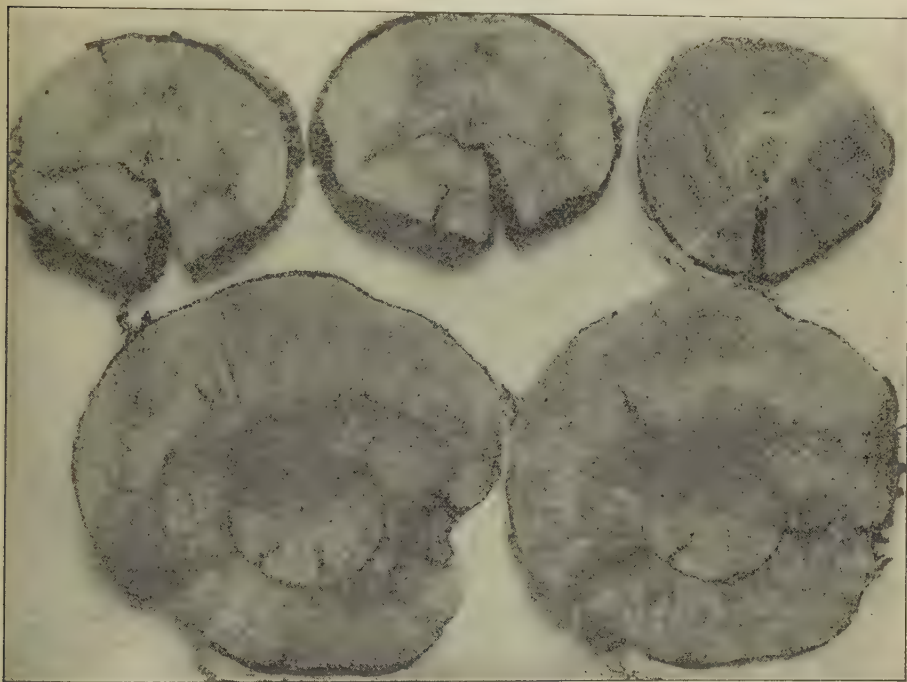


Photo. Oct. 26, 1908

FIG. 55.—*Niagara*. Cross sections of diseased stems (natural size)

might be carried along and forcibly injected into healthy vines. Until infections were found on the green shoots these two methods were thought to be commonest and perhaps the only means of infection. The idea that it is a common method is supported by several facts. The action of the fungus on the old hardwood of the vine is very slow and the progress made is much like that of a *wound parasite*. This term is one which is frequently used in reference to heart diseases of trees.

Atkinson ('01) has shown that some fungi producing heart rot cannot gain entrance to the tree except the living layer be removed, as in the case of a wound. The heart wood of a tree is dead and it is in this that the semi-parasite gets a footing. Longitudinal and cross sections of an old diseased grape stem (Figs. 54, 55) show that the fungus has developed in a very similar way; very slowly and each year adding a new circle of diseased wood. The cambium layer or growth area

tries to heal over the wound, but is irritated by the action of the fungus and develops the corky excrescences instead. Eventually, the stem is completely girdled and the vine dies, but during this process exhibits some one or all of the various phases mentioned under signs of the disease.



Photo. June 22, 1908

FIG. 56.—Concord. An apparently healthy renewal, four years old. The old trunk, which was diseased, was pruned off last winter.

Distribution through diseased stock

But now comes an even more serious consideration. It has been possible to obtain pure cultures of the *Fusicoccum* by stripping back the bark of a green shoot and removing under sterile conditions a bit of the diseased tissue to sterilized stems (Fig. 53). It would seem quite probable then that the fungus might readily live over the winter in such places and continue its growth the following year. If such

is the case and diseased canes were used for cutting they would eventually yield diseased vines.

Some nurserymen practically trim a vineyard for the privilege of carrying away the brush for cuttings, while in other cases owners make the cuttings and sell to the nurserymen by the thousand. In either case, no attempt is made to sort out the diseased canes, since the spots on the canes are not regarded as having any connection with a disease. Thus it is to be expected that the nurserymen often use diseased material for stock. This is also more probable when the very general distribution of this disease is noted. The progress of this disease is

('01) Atkinson, G. F. Studies of some Shade Tree and Timber Destroying Fungi. Cornell Univ. Agr. Exp. Sta. Bull. 193:199-235, 1901.

not very rapid and it would be possible, no doubt, to obtain a two-year-old grape root that would show no signs of the disease. In a few years more, however, the effect would be very marked. This appears to be the explanation of the dying of so many vines in the young vineyards at Brocton and elsewhere.

Experiments are now under way to determine means of detecting diseased cuttings in the nursery as well as to find out what percentage of the vines are diseased when spotted canes are used as stock. Obviously, this will require observations for several years, and so long as results of this test are lacking the above must remain hypothetical. As a hypothetical condition, however, it is worthy of consideration since a little care in the selection of stock now may be the means of saving a great deal of expense and labor later.

CONTROL

Obviously, the spraying or washing of the trunk with vitriol or other poisonous chemicals will have no effect in curing a diseased vine. The fungus is inside and cannot be reached in this way. The problem of the cure of a diseased vine would be that of injecting, or feeding through the roots



Photo. June 22, 1908

FIG. 57.—Concord. A diseased renewal. Disease had worked into root before old trunk was pruned off

(as fertilizer), some toxic substance. But such a procedure would assume that the fungus would more readily succumb to the poison than the living cells of the vine itself, and while such instances are known in the case of some fungi (Massee '03), so far as the writer knows no one has made an attempt to determine the facts in the case of this organism. Even if such a method of treatment should cure a vine, it is questionable whether it would be practicable and for that reason should be left to the investigator to determine. Such experiments are planned for another year.

The thorough spraying of the trunks and green shoots of the vines late in May and early June would be of value in preventing new infections from the spores developed at that time. Many vineyardists spray for fungous rots and insect pests, and it would be an easy matter to give the trunks a little more attention. For those who spray for insect pests alone it would not be a great deal more expensive to make up the insect poison in Bordeaux mixture, using the same proportions as though the Bordeaux mixture were water.

Since a vine once diseased is almost sure to die sooner or later, eradication would seem to be one of the best means of control. A diseased vine left in the vineyard is a menace to its neighbors and may be the center for a general infection. Eradication of this disease means the renewal of the entire vine or of only a part of it. Figure 57 represents a case in which the removal of the entire vine would be necessary. Figure 54, which is the same vine as is shown in Figure 43, illustrates a case in which the whole root crown is still healthy and by cutting off the trunk near the ground the large sucker seen in Figure 43 would soon develop into a healthy vine.

A number of the Chautauqua vineyardists practice this renewal system in a general way, but Mr. John B. Goggin, at Silver Creek, has set about systematically to eradicate this disease. In 60 acres, he has renewed about one-fourth of the vines. On June 22, 1908, the writer had the opportunity of going over, with Mr. Goggin, this vineyard where many renewals of four and five years were bearing an excellent crop of fruit and were apparently in perfectly healthy condition (Fig. 56). Occasionally a renewal has come diseased (Fig. 57), and it was because of such cases that this visit was made. Apparently there were two diseases in the vineyard, one that could be controlled by the renewal system, another that could not. A study of Figure 54 will reveal the true source of the difficulty. In most cases Mr. Goggin had eradicated the disease but in some the fungus had grown into the root crown and thence into the renewal. According to Mr. Goggin's observations, repeated re-

newals from such a root come diseased, usually in their second year (Fig. 57).

Experienced trimmers assert that they can detect diseased vines by the appearance of the wood. That this is not always true is very evident. In many vineyards, the writer has used as a criterion of this disease the fact that a vine had been trimmed and tied up and yet failed to put out shoots. It would seem then that the best time to mark such vines for the eradication of the disease would be in the spring and summer when some one of the characters given above and illustrated in the photographs would be evident even to the laborer. Every laborer could be supplied with some wooden tags with a fine wire or with some strips of lath or shingle, and the diseased vines could be marked in this way with practically no extra expense or loss of time.

In cutting off such vines, care should be taken to get below the diseased area. There is no difficulty in detecting disease in the sawed end of a trunk, but it must be remembered that the fungus may have traveled farther than the brownish area. It is strongly recommended that a separate set of tools be carried for the removal of diseased vines. When the old trunk is cut off the stub should be coated with a heavy oil lead paint. Ordinarily the diseased vines are not of so frequent occurrence that one extra set of tools would be insufficient for a squad of six or more trimmers. In this way, the danger of infecting healthy vines by way of the pruning shears or saw would be avoided. The lead paint should be smeared over the exposed stub to prevent any stray bit of diseased wood from producing infection, or the subsequent entrance of this or other rot fungi.

In the case of vines just beginning to show the disease, some growers have asked whether it would not be just as well to leave the vine, getting such a crop from it as would bear while the renewal was being trained up and brought into bearing. The main object in leaving the old trunk would be to protect the renewal from being broken off by the horse hoe, etc. This is what Mr. Goggin does but in general it is not likely to give the best results. The sooner the diseased vine can be removed the better. In case there is danger of breaking off the renewal, a lath could be used to mark it, which could easily be put in by the person who is trying the vines.

STATEMENT

If at any time there is doubt as to the identity of this disease, growers are invited to send specimens of the diseased wood to the Department of Plant Pathology, New York State College of Agriculture, Ithaca, N. Y. An examination of the material will gladly be made and the result of the examination reported.

CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION

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135 Forage Crops.
136 Chrysanthemums.
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